



# Lighting Energy Code Hot topics

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# New Interior Lighting Power Densities (LPD)

- Currently in 90.1-2004, IECC 2003/2004
- IECC 2003/2004 = pre-90.1-2004 reference
  - LPD mismatch?
- Where did these come from and why?
  - Developed by 90.1 lighting subcommittee
  - Similar development process as 90.1-1999/2001
  - New LPDs are an “update” of 90.1-2001 LPDs

# Basic LPD Development

**Similar general process for 90.1-1999, 2001, 2004**

**Apply:**

- Current lighting product performance data
- Current lamp/ballast efficacy and light loss factors
- Latest IES recommended light levels
- Professional consensus of quality lighted environments
- Combine these elements into building space models to calculate lighting power densities
- Apply space type LPDs to real building data to generate whole building LPDs

# “New” LPD development

- Revisit and update all model inputs:
  - Latest lighting product performance data
  - Latest lamp/ballast efficacy and light loss factors
  - Latest IES recommended light levels
  - Professional consensus of quality lighted spaces



# Latest IES recommended light levels

| 9th Edition<br>OPTIONS |                                |   | LUX |         | 8th Edition                    |   | LUX          |
|------------------------|--------------------------------|---|-----|---------|--------------------------------|---|--------------|
|                        |                                |   |     |         |                                |   |              |
|                        |                                |   |     |         |                                |   |              |
| Court Rooms            | Seating area<br>(spectators)   | C | 100 |         |                                |   |              |
|                        |                                |   |     |         |                                |   |              |
| Reading                | Photograph,<br>moderate detail | E | 500 | Reading | Photograph,<br>moderate detail | E | 500-750-1000 |
| Reading                | Photocopies                    | D | 300 | Reading | Photocopies                    | D | 200-300-500  |
| Reading                | VDT screens                    | A | 30  | Reading | VDT screens                    | B | 50-75-100    |
| Reading                | keyboard reading               | D | 300 | Reading | keyboard reading               | D | 200-300-500  |
| Reading                | 6-point type                   | E | 500 | Reading | 6-point type                   | E | 500-750-1000 |
| Reading                | 8- and 10-point<br>type        | D | 300 | Reading | 8- and 10-point<br>type        | D | 200-300-500  |
| Reading                | Glossy magazines               | D | 300 | Reading | Glossy magazines               | D | 200-300-500  |
| Reading                | Maps                           | E | 500 | Reading | Maps                           | E | 500-750-1000 |
| Reading                | Newsprint                      | D | 300 | Reading | Newsprint                      | D | 200-300-500  |
| Reading                | Typed originals                | D | 300 | Reading | Typed originals                | D | 200-300-500  |

# Application Model Inputs

- Appropriate illuminance for general and task lighting
- Percent of space lighting supplied by each

These determine average weighted illuminance for the space

|             |              |  |                |                 |  |          |
|-------------|--------------|--|----------------|-----------------|--|----------|
|             |              |  |                |                 |  |          |
| Task Area % | Task Area FC |  | General Area % | General Area FC |  | Total FC |
| 50          | 50           |  | 50             | 20              |  | 35       |
|             |              |  |                |                 |  |          |

# Application Model Inputs

- Allocate illuminance to up to 3 different luminaire types
- Luminaire efficiency determined by lamp efficacy (LE), CU, and loss factors (LLD, LDD, RSDD)

These determine the light delivery efficiency of the luminaires

| SYSTEM #1 |              |                          |
|-----------|--------------|--------------------------|
| % FC      | Light Source | Light Distribution       |
| 75        | FL           | Linear Dir/Indir         |
| SYSTEM #2 |              |                          |
| % FC      | Light Source | Light Distribution       |
| 15        | FL           | Task                     |
| SYSTEM #3 |              |                          |
| % FC      | Light Source | Light Distribution       |
| 10        | FL           | Linear WW open - 2 walls |

# Application Model Inputs

- Consensus choice of appropriate typical room geometry – Room Cavity Ratio (RCR)

This helps set luminaire efficiency at expected room geometry

| LIGHTING POWER DENSITY |        |       |          |         |
|------------------------|--------|-------|----------|---------|
| RCR                    | RCR>2  | RCR   | PRIMARY  | PRIMARY |
| <2.5                   | & <7.0 | >7.0  | LPD      | RCR     |
|                        |        |       |          |         |
| 0.478                  | 0.711  | 0.858 | 0.711456 | 2       |
| 0.84                   | 1.279  | 1.558 | 1.279026 | 2       |
| 1.226                  | 1.759  | 2.076 | 1.759399 | 2       |
| 0.239                  | 0.395  | 0.465 | 0.464545 | 3       |
| 0.875                  | 1.431  | 1.759 | 1.430762 | 2       |



# Whole Building LPD Development

- Develop detailed space by space data for commercial buildings
  - Use sets of new building construction plans (DODGE)
  - Detailed drawing takeoffs = sqft by space type
  - Current set at 246 buildings for 31 bldg types
- Assign applicable space type model LPD for each space
- Calculate whole building LPD



# Whole Building LPD Development

## POST OFFICE Whole Building

| Building and Space Description | Space Appl. Factor | Model # | Model LPD | Space Wtd LPD | LPD Sum                  | Bldg Appl % | Bldg Wtd LPD                  | Bldg Type Wtd Avg LPD |
|--------------------------------|--------------------|---------|-----------|---------------|--------------------------|-------------|-------------------------------|-----------------------|
| A                              | B                  | C       | D         | E             | F                        | G           | H                             | I                     |
| <b>17,342 ft<sup>2</sup></b>   |                    |         |           |               | 1.56                     | 0.25        | 0.39                          | 1.55                  |
| Conference                     | 0.013              | 31.00   | 1.50      | 0.019         | Sum of column E for bldg | F x G       | Sum of column H for bldg type |                       |
| Corridor                       | 0.009              | 2.00    | 0.73      | 0.006         |                          |             |                               |                       |
| Locker Room                    | 0.070              | 24.00   | 0.81      | 0.057         |                          |             |                               |                       |
| Elec/Mech                      | 0.009              | 4.00    | 1.29      | 0.011         |                          |             |                               |                       |
| Recreation                     | 0.048              | 9.00    | 1.40      | 0.068         |                          |             |                               |                       |
| Office - encl.                 | 0.024              | 25.00   | 1.54      | 0.037         |                          |             |                               |                       |
| Office - open                  | 0.020              | 27.00   | 1.28      | 0.026         |                          |             |                               |                       |
| Lobby                          | 0.069              | 20.10   | 1.75      | 0.121         |                          |             |                               |                       |
| Reception                      | 0.003              | 12.00   | 0.97      | 0.003         |                          |             |                               |                       |
| Storage                        | 0.006              | 11.00   | 0.93      | 0.006         |                          |             |                               |                       |
| Workshop                       | 0.042              | 41.00   | 1.13      | 0.048         | Sum of column E for bldg | F x G       | Sum of column H for bldg type |                       |
| Lobby                          | 0.021              | 35.00   | 2.47      | 0.051         |                          |             |                               |                       |
| Lobby                          | 0.115              | 88.00   | 1.52      | 0.176         |                          |             |                               |                       |
| Sorting Area                   | 0.551              | 34.00   | 1.70      | 0.934         |                          |             |                               |                       |
|                                | 1.000              |         |           |               |                          |             |                               |                       |
| <b>13,971 ft<sup>2</sup></b>   |                    |         |           |               | 1.53                     | 0.25        | 0.38                          |                       |
| Active storage                 | 0.058              |         |           |               | B x D                    |             |                               |                       |
| Workshop                       | 0.022              |         |           |               |                          |             |                               |                       |
| Dining Area                    | 0.025              |         |           | 0.036         |                          |             |                               |                       |
| Restrooms                      | 0.012              | 12.00   | 0.97      | 0.012         |                          |             |                               |                       |
| Locker Room                    | 0.046              | 24.00   | 0.81      | 0.037         |                          |             |                               |                       |

Data from  
bldg plans

Space  
model &  
LPD

B x D

Sum of  
column E  
for bldg

F x G

Sum of  
column H  
for bldg  
type

# Space by Space LPD Comparison

| Model | Building Type            | Space Type description          | 2004<br>LPD | 2001<br>LPD | %<br>Change |
|-------|--------------------------|---------------------------------|-------------|-------------|-------------|
| 1.02  | Auditorium               | Audience/Seating Area           | 1.76        | 2.47        | (28.69)     |
| 3.1   | NA (typical all bldgs)   | Classroom/Lecture/Training      | 1.43        | 1.59        | (9.84)      |
| 3.2   | Court House              | Courtroom                       | 1.94        | 2.13        | (9.16)      |
| 7.03  | Lounge/Leisure Dining    | Dining Area                     | 1.40        | 1.24        | 13.19       |
| 7.04  | Family Dining            | Dining Area                     | 2.10        | 2.23        | (5.87)      |
| 15    | Office                   | Laboratory                      | 1.38        | 1.84        | (24.94)     |
| 17    | Library                  | Stacks                          | 1.71        | 1.89        | (9.55)      |
| 19    | Library                  | Reading Area                    | 1.17        | 1.77        | (33.54)     |
| 20.1  | NA (typical all bldgs)   | Lobby                           | 1.32        | 1.75        | (24.60)     |
| 22    | NA (typical all bldgs)   | Atrium - first three floors     | 0.63        | 1.31        | (52.28)     |
| 23    | NA (typical all bldgs)   | Atrium - each additional floor  | 0.16        | 0.20        | (16.43)     |
| 25    | NA (typical all bldgs)   | Office - enclosed               | 1.13        | 1.54        | (26.56)     |
| 27    | NA (typical all bldgs)   | Office - open plan              | 1.06        | 1.28        | (17.16)     |
| 31    | NA (typical all bldgs)   | Conference Meeting/Multipurpose | 1.25        | 1.50        | (16.58)     |
| 35.1  | Manufacturing Facility   | General Low Bay                 | 1.15        | 2.14        | (46.15)     |
| 35.2  | Manufacturing Facility   | General High Bay                | 1.67        | 2.98        | (43.97)     |
| 37    | Manufacturing Facility   | Detailed                        | 2.08        | 6.22        | (66.54)     |
| 84    | Museum                   | General exhibition              | 1.02        | 1.57        | (35.10)     |
| 85    | Museum                   | Restoration                     | 1.69        | 2.47        | (31.49)     |
| 91    | Performing Arts Theatre  | Audience/Seating Area           | 2.60        | 1.76        | 47.51       |
| 92    | Motion Picture Theatre   | Audience/Seating Area           | 1.16        | 1.31        | (11.11)     |
| 93.1  | Performing Arts theatre  | Lobby                           | 3.27        | 1.24        | 163.06      |
| 93.2  | Auditorium               | Lobby                           | 1.05        | 0.80        | 31.80       |
| 118   | Gymnasium                | Playing Area                    | 1.35        | 1.88        | (28.13)     |
| 201   | Retail [ave of 94,97,98] | Merchandising Sales Area        | 1.70        | 2.47        | (30.96)     |

# Whole Building LPD Comparison

| Bldg Type                   | 2004 Whole BLDG LPD | 2001 Whole BLDG LPD | % Change from 2001 |
|-----------------------------|---------------------|---------------------|--------------------|
| AUTOMOTIVE FACILITY         | 0.9                 | 1.5                 | (40.00)            |
| CONVENTION CENTER           | 1.2                 | 1.4                 | (14.29)            |
| COURTHOUSE                  | 1.2                 | 1.4                 | (14.29)            |
| DINING: BAR LOUNGE/LEISURE  | 1.3                 | 1.5                 | (13.33)            |
| DINING: CAFETERIA/FAST FOOD | 1.4                 | 1.8                 | (22.22)            |
| DINING: FAMILY              | 1.6                 | 1.9                 | (15.79)            |
| DORMITORY                   | 1.0                 | 1.5                 | (33.33)            |
| EXERCISE CENTER             | 1.0                 | 1.4                 | (28.57)            |
| FIRE STATIONS               | 0.8                 | 1.3                 | (38.46)            |
| GYMNASIUM                   | 1.1                 | 1.7                 | (35.29)            |
| HEALTHCARE-CLINIC           | 1.0                 | NA                  | NA                 |
| HOSPITAL                    | 1.2                 | NA                  | NA                 |
| HOSPITAL/HEALTHCARE         | NA                  | 1.6                 | NA                 |
| HOTEL                       | 1.0                 | 1.7                 | (41.18)            |
| LIBRARY                     | 1.3                 | 1.5                 | (13.33)            |
| MANUFACTURING               | 1.3                 | 2.2                 | (40.91)            |
| MOTEL                       | 1.0                 | 2.0                 | (50.00)            |
| MOTION PICTURE THEATRE      | 1.2                 | 1.6                 | (25.00)            |
| MULTI-FAMILY                | 0.7                 | 1.0                 | (30.00)            |
| MUSEUM                      | 1.1                 | 1.6                 | (31.25)            |
| OFFICE                      | 1.0                 | 1.3                 | (23.08)            |
| PARKING GARAGE              | 0.3                 | 0.3                 | 0.00               |
| PENITENTIARY                | 1.0                 | 1.2                 | (16.67)            |
| PERFORMING ARTS THEATRE     | 1.6                 | 1.5                 | 6.67               |
| POLICE STATIONS             | 1.0                 | 1.3                 | (23.08)            |
| POST OFFICE                 | 1.1                 | 1.6                 | (31.25)            |
| RELIGIOUS BUILDINGS         | 1.3                 | 2.2                 | (40.91)            |
| RETAIL                      | 1.5                 | 1.9                 | (21.05)            |
| SCHOOL/UNIVERSITY           | 1.2                 | 1.5                 | (20.00)            |
| SPORTS ARENA                | 1.1                 | 1.5                 | (26.67)            |
| TOWN HALL                   | 1.1                 | 1.4                 | (21.43)            |
| TRANSPORTATION              | 1.0                 | 1.2                 | (16.67)            |
| WAREHOUSE                   | 0.8                 | 1.2                 | (33.33)            |
| WORKSHOP                    | 1.4                 | 1.7                 | (17.65)            |

➤ Average weighted change = 25% reduction across national building mix



# Additional Interior Lighting Power

## For Space-by-Space Compliance ONLY



- Decorative luminaires in addition to the general lighting  
1.0 W/ft<sup>2</sup>
- Use of Specific luminaires to eliminate computer screen glare - 0.35 W/ft<sup>2</sup>
- Retail Display Lighting: But only for display area!
  - Additional 1.6 W/ft<sup>2</sup> , or
  - Additional 3.9 W/ft<sup>2</sup> for fine merchandise
- [All must be for specific use only and separately switched]

# New Exterior LPDs

- Currently in 90.1-2004, (proposed for IECC 2006)
- Previous and current exterior requirements
  - Lamp efficacy (90.1 was 60 lm/W, IECC at 45 lm/W)
  - Limited LPDs (90.1 had entrance/exit/façade, IECC – NA)
  - Controls
- Where did these come from and why?
  - Developed by 90.1 lighting subcommittee
  - Prompted by advocacy groups and need to update



# Exterior LPD Development

- Review of existing exterior lighting documents:
  - IESNA 9th Edition Handbook
  - IESNA RP-33, RP-02, RP-20, RP-10 (draft)
  - IESNA DG-5
  - State Outdoor Lighting Standards
- Creation of multiple lighting solution models:
  - parking areas
  - Walkways/Plazas
  - Building entries/exits
  - Canopies
  - Façade lighting
  - Outdoor sales
- Metal Halide used as base case!



# Building Exteriors LPDs (Tradable)

| Applications   | Lighting Power Densities           |
|--|------------------------------------|
| <b>Tradable Surfaces</b>   |                                    |
| (Lighting Power Densities for open parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded) |                                    |
| <b>Uncovered Parking Areas</b>   |                                    |
| Parking Lots and drives  | 0.15 W/ft <sup>2</sup>             |
| <b>Building Grounds</b>  |                                    |
| Walkways less than 10 feet wide  | 1.0 Watts/linear foot              |
| Walkways 10 feet wide or greater, Plazas, Special feature areas  | 0.2 W/ft <sup>2</sup>              |
| Stairways  | 1.0 W/ft <sup>2</sup>              |
| <b>Building Entrances and Exits</b>  |                                    |
| Main Entries   | 30 Watts/linear foot of door width |
| Other doors  | 20 Watts/linear foot of door width |
| <b>Canopies and Overhangs</b>  |                                    |
| Canopies (free standing & attached) and overhangs  | 1.25 W/ft <sup>2</sup>             |
| <b>Outdoor Sales</b>   |                                    |
| Open areas (including vehicle sales lots)  | 0.5 W/ft <sup>2</sup>              |
| Street Frontage for vehicle sales in addition to "open area"   | 20 Watts/linear foot               |



# Building Exteriors LPDs (Non-Tradable)

| Applications   | Lighting Power Densities   |
|--|--|
| <b>Non-Tradable Surfaces</b><br>(Lighting Power Density calculations for the following applications can only be used for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowance's are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.) |  |
| Building Facades   | 0.2 W/ft <sup>2</sup> for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length  |
| Automated Teller Machines & Night Depositories   | 270 watts per location plus 90 watts per additional ATM per location   |
| Entrances and Gatehouse Inspection Stations at guarded facilities  | 1.25 W/ft <sup>2</sup> of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces) |
| Loading Areas for Law Enforcement, Fire, Ambulance and other Emergency Service Vehicles  | 0.5 W/ft <sup>2</sup> of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)  |
| Drive-up Windows at Fast Food Restaurants  | 400 watts per drive-through  |
| Parking near 24-hour Retail Entrances  | 800 watts per main entry   |

# Exterior Application Issues

- “Retail Competition”
  - Proximity comparison
  - Sales – Display
- New requirements
  - Odd applications
  - “Let the games begin”
- Some help
  - trade-off capability
  - 5% adder



# Controls, Exceptions, Etc.

- “by occupant intervention”
  - The mother of all typos
  - Fixed in 90.1-2001 (proposed for IECC 2006)
- Exceptions
  - Safety/patient care spaces vs. auto lighting shutoff
  - Power density calculation exceptions
- Building/Space type matches
- Task Lights

